XIX. *On asymmetry in the Males of* Hemarine *and other Sphinges.* By Thomas Algernon Chapman, M.D., F.Z.S.

[Read May 7th, 1902.]

Plates XXIV. and XXV.

A want of bilateral symmetry in insects has been recorded of a great many different species and groups, in many different orders. In the Lepidoptera, however, the recorded instances are few, practically the only well-known instance is in the genus *Thanaos* of Hesperid butterflies; I am indebted to Dr. Sharp for references to instances occurring also in *Butalidæ*, *Pterophoridæ*, and *Psychidæ*, recorded in a paper by Poljanec in Arb. Inst., Wien, xiii, 1901, pp. 155—196, and he informs me that minor instances affect certain *Noctuidæ*.

In the *Sphinges* it affects the whole family, probably affects every species, though there are certainly a good many in which, if present, it is reduced to so evanescent a degree that I have not detected it.

When asymmetry occurs in insects, it affects the sexual appendages in a great majority of recorded instances, this is so in all the cases of Lepidoptera I have just referred to, and is also the case in the Sphinges.

Gosse in his paper in the Linnæan Trans., mentions that the *Ædœagus* of *Papilio mennon* is curved towards the right side, and he implies vaguely a similar condition in one or two other species.

Except in the *Hemarids*, the asymmetry in *Sphinges* affects only the *ædœagus* in any species I have examined, and does so in many curious forms. In the Hemarines (clearwings) it has gone further and affects the harpes, the valves, and even the tegumen.

My object in this paper is merely to call attention to the facts from a morphological point of view, without attempting any systematic applications, beyond stating my belief that a classification and revision of the Sphinges on the characters of the male genitalia alone would give us better results than any we now have, and that these azygos

developments would no doubt prove to afford an important part of the data.

Why asymmetry of the central organ should be so common in the group and not have passed to the other parts except in the one minor subfamily of *Hemarinæ* I do not know, it is not impossible that it has in fact done so, in cases of which I have no knowledge.

I cannot help thinking that in the LEPIDOPTERA asymmetry of the *ædœagus* is probably really very much more frequent than we imagine. Unless exceedingly pronounced, the two commonest ways of mounting the appendages for examination would probably lead to its being entirely overlooked. One is to mount the parts on a glass slide, the other to separate the parts and mount each separately on a card or mica slip. In either of these ways the precise orientation of the *ædœagus* would be very likely, if not certain, to be lost, and the opening really existing on the right side of the tube would be believed to be below, and any azygos appendage of the left side would be assumed to be dorsal (or possibly ventral). The Sphinges are so large that there is no difficulty in preserving the specimens in their natural positions (approximately), and examining them so. Even in *Papilio*, however, in which Gosse apparently followed this plan, he appears to have met with some unilateral deviations, which he explained away as merely apparent and probably due to rotation of the tube on its axis.

In the *Hemarinæ*, where the asymmetry affects the valves, and more especially their inner spines (harpes), the nature of the asymmetry is different from that obtaining in the genus *Thanaos*. In the first place Scudder makes no mention of the *ædœagus*, which one assumes therefore to be symmetrical. The remarkable differences in the valves of the two sides, strike one as being complementary. The work to be done on either side is precisely the same as that on the other, and neither valve is definitely larger or smaller, more twisted one way or other, than the other one. The object would appear to be, not only to do its own work better, but to assist the valve of the other side in doing the same, just as in the much simpler apparatus of a catch forceps, the teeth on the two sides differ, not to perform different functions, but really identical functions more efficiently.

In *Hemaris*, the two sides differ by actual diminution

of size and complexity affecting one side without very great change in the other; and in addition to this the diminishing side appears to retain or increase its range of movement, the larger side, by comparison at any rate, losing it. The arrangements would seem to imply that in pairing, approach is made laterally and not vertically, and that to admit of this occurring more readily one side becomes smaller and more movable.

A similar change, apparently for a similar reason, is, I believe, not infrequent in COLEOPTERA, perhaps it is only ignorance that leads us to believe it rare in Lepidoptera. Since it is, I think I may say, the rule, in Lepidoptera for the insects to approach each other laterally, although the mobility of the abdominal segments prevents this affecting the actual pairing organs. It is, also, probable that the approach is as often made from one side as from the other, but on this point I have neither made nor heard of any observations, beyond knowing that I have often, but in what species I do not remember, seen the male endeavouring to reach the female, first from one side, then from the other, perhaps several times, before succeeding in his endeavours.

Still less can I guess as to the conditions obtaining in this aspect, in the nearly allied family of the *Trichoptera*, in which Mr. McLachlan records some striking instances of asymmetry in the whole genus *Glossosoma* (European Trichoptera, p. 468), as well as in *Letodes interrupta* (p. 340) and *Leptocerus inaequalis* (First additional supplement, p. 34), in all cases with figures.

To give any general description of the asymmetry of the *ædœagus* as it occurs throughout the whole family of Sphingides is practically impossible, so many different forms does it assume.

It is reduced to vanishing point in *A. convolvuli*, *M. atropos*, *Sp. ligustri*, and *Ambulyx rostralis*, where the tube is cylindrical and the opening terminal. In *Mimas tiliæ* and *A. populi* it appears to be actually or very nearly symmetrical, but there is a great difference in the armature of great spines on the eversible membrane (true *penis*), between the two sides. In *Sm. ocellatus* there is a great bluntly-pointed projection on the left margin of the terminal opening. It is rather rare to have this eversible membrane in evidence, so that its peculiarities remain easily unobserved, but except in some Amorphids I have not observed it armed in any way.

In Macroglossa the tube is very short and wide; besides less easily described irregularities, it carries a curved spine, arising on the right side and curving over the dorsum, parallel to the margin. *Rhopalopsyche* and *Rhodosoma* are not very dissimilar, *Enyo*, *Sataspes*, and *Aellopus* incline rather to follow the pattern of *Hemaris*, in which the *ædœagus* is extremely slender and rather long, and has a spine, continuing the line of the tube from its left margin, so that the tube appears to taper to a point and to have the opening on the right side, just where the tapering commences. The difficulty of grounding ideas of relationship on similarity of these structures is illustrated by the very similar structure in *Sphinx pinastri*, where the tube is long and very slender and ends in a similar point to that in *Hemaris*, it is however on the right side and has two subsidiary processes beside or opposite to it.

In *Deilephila* (*Euphorbiæ*, *galii*, *lineata*) there is a curious valvular arrangement, in connection with a strong armed ridge running down the right margin.

In the genus *Hemaris* the slenderness of the *ædœagus* makes it easy to overlook its asymmetrical character, but here the harpes and valves have become involved.

In *Sphinges* (broadly) the valves are wide and large and free from any special developments, basally and ventrally however there are, when present, the harpes, consisting on each valve of a rather swollen base which carries a process, that lies just within the margin of the valve, sometimes a thick baton, a short or a very long slender hook more or less curved, etc.; and nearer the centre of the valve another usually conical process or spine. The latter is very usually absent, it is apparently, hardly, if at all, represented in *Hemaris*. It possesses, however, the first process as a straight baton somewhat bulbous at the end, or at least one supposes the original Hemaris with the parts symmetrical did so. The first step in asymmetry is for this process to disappear on the left side, it tended next to disappear on the right also, but meantime the left valve became emarginate, and so in *Hemaris* there are varying degrees of loss of the batons and emargination of the valves, always far advanced on the left side.

In *Cephonodes*, the batons are entirely gone, and a great emargination of the left valve occurs. In the Indian *Hylas* the two cusps at the margins of the left valve are much alike in structure. An apparently identical insect, from I

imagine Africa, has the upper cusp with somewhat reduced neck and rounded spinous head.

To return to *Hemaris*, in *Bombyliformis* (*tityus, scabiosæ*) the emargination of the valve requires careful comparison with the opposite valve in order to feel sure of it, the baton of the harpe is well developed on the right side, represented by the minute elevation on the other. *Croatica*, which looks as if closely allied to *Fuciformis*, has the appendages very nearly identical with those of *Bombyliformis*. In *Fuciformis*, the baton of the left harpe is a slight projection, the right one is very small, but apparently of the same structure as in *Bombyliformis*.

In *Thysbe*, the form of the right baton differs a little from that of *Bombyliformis* but it is fully as large, whilst the left one is represented by a very small thimble-shaped process. The emargination of the left valve is marked. *H. diffinis* again has a somewhat different form of baton, but the left is of exceedingly reduced proportions, although the valves seem to be symmetrical. There is some indication of the tegumen being twisted; this is very marked in *Cephonodes*, where even its base on one side differs from the other.

In *Cephonodes hylas* (India), the *ædœagus* is very long and very slender, the terminal spine has all the appearance of being a continuation of the shaft gradually diminishing to a point, with the opening a short way from the extremity and on the right side. The right clasp is large, salver-shaped, somewhat imperfectly articulated at the base, so that its range of movement is very restricted. The left clasp is much smaller, in form as if it had had the same outline as the right, but had had a large terminal disc excised, leaving an upper, narrower longer, and lower shorter and broader cusp. It is shorter than the right, as about 3—5, if its emarginate outline allows a length to be given it. The arrangement of bristles, etc., differs from that on the right side. It is much more movable on its articulation than the right one. The articulation seems incomplete in all these Hemarids, *i. e.* the connecting, articulating membrane is not mere membrane, but is fairly chitinized, and does not, for instance, tear readily for disarticulation. The great gap in the left clasp is clearly homologous to the emargination in that of *Hemaris*. This is on the lower margin in *Hemaris*, but the portion below it has here become more extended,

that above (the main part of the valve in *Hemaris*) so diminished that the emargination is now terminal and not ventral.

The tegumen is also affected, its right swollen base is much larger than the left (as seen from above), largely owing to its being horizontal in position and that on the left more vertical, but there is an actual difference; beyond this is a laterally flattened shaft, which twists, so as to throw the upper edge of the end right over to the left side, and so the descending hook-like process below this bends over very much to the right. There is no subanal process.

In *Hemaris* the tegumen seems to be unaffected.

Hemaris bombyliformis (*scabiosæ*, *tityus*).—The differences between the two sides here are marked, and affect several portions of the appendages. The *ædœagus*, which is here extremely long and extremely slender, perhaps 6 m.m. in length, if separated, has the hook or flange developed into a straight spine nearly ·7 m.m. in length, and looking like a continuation of the shaft of the *ædœagus*. It does, however, bend a little upwards and to the left, so that the opening faces a little to the right and downwards.

There is a membranous (double) sheath to the *ædœagus*, which has much the same size and aspect as the sheath in some others (*Proserpina*, *Idricus*, *Sataspes*, etc.); it seems larger and fuller on the right side, but in soft parts softened, one cannot depend much on this being the natural aspect.

The double upper piece (tegumen) seems to be quite symmetrical, but the side pieces (valve and harpe) are quite different on the two sides, at least the lower spinous portion (harpe) is so, very markedly. When the valves are separated, the most ventral portion of each, where they meet in the middle line, presents an inflated, ovoid piece, a piece of about 1 m.m. in length. On the left side this piece carries at its summit a series of dark, short, spine-like bristles, on the right side it is produced into a cylindrical process a full m.m. long, and ending in a rounded slightly bulbous end, clothed with similar bristles to those sessilely placed on the other side. It is not very clear whether there is any sort of articulation between this (harpe ?) and the long spatula-like valve proper. The left valve may be described as being deeply notched opposite

the wanting process of the harpe, but perhaps more correctly as having a short expansion below this quite at its base.

The *ædœagus* itself when extended is directed somewhat to the right side; so that we have in a plane, passing from below upwards, from the right side to the left and obliquely, so that it would in front be to the left, firstly, the long harpe of the right side, then the longest portion of the sheath, then the opening of the *ædœagus*, and then the shaft of the *ædœagus*, with the terminal spine directed straight backwards, the oblique position of the *ædœagus* just equalling the bend at the orifice made by the spine.

Hemaris croatica has the *ædœagus* almost identical with that described under *bombyliformis*. The lower (harpe) portion of the valve carries, as in *bombyliformis*, only on the right side a long process with round curved shaft and bulbous extremity, represented on the left side by only a few bristles; the large flat portion of valve has on the left side a deep sinuation or notch, opposite the place where the lower piece is, on this side, wanting.

H. diffinis.—Of two prepared specimens of this, the tegumen in both is twisted to the left. I have not noticed this definitely elsewhere. I am not prepared, however, to feel sure that the appearance is not artificial, due to the greater mobility of one clasp, twisting the basal ring, when both are forced equally apart. The opening of the sheath is definitely on the left, *i. e.* its prolonged apex is to the right. The *ædœagus* is very like that of the other Hemarids, slender, with opening to right and a point beyond directed to the left; this point is very little, if anything, beyond the prolonged opening of the *ædœagus*. The basal bulla of the clasp is more specialized, having a very definite process near its distal extremity, projecting inwards, rounded and very finely spiculated. On the right side is the usual prolongation, rather longer than usual and much more slender; on the left side it is represented by an extremely short rounded process. Both these processes are united basally to the flat portion of the valve, as does not occur in the other species examined, and the valves themselves are broad without emargination, and not very definitely asymmetrical in any way, except in the union with the harpe processes.

In *Fuciformis* the asymmetry would almost escape

notice unless looked for. There is a well-developed symmetrical sheath, the *ædœagus* itself is very long and very slender, as in *bombyliformis*, but though the opening is to the right side the process beyond it is short and blunt, at least viewed laterally, viewed dorsally it seems very sharp; in reality, it is merely the lip of the terminal opening, prolonged on the left side. The ventral basal inflations of the valves are much the same on both sides; the left one terminates in a rather sharp angle, with some bristles, the right in a process like that of *bombyliformis* and *croatica*, but by comparison ridiculously minute, so as to be easily overlooked. The flat portion of the valve is deeply emarginate on both sides, so as to present a long slender strip, with a basal projection (the piece below the emargination) on the ventral side. This basal projection is much narrower on the left side.

H. thysbe has a sheath symmetrical and even more fully developed than in *fuciformis*. The *ædœagus* is a little more robust, has the opening to right side and a spine continued a little beyond it, with a little flexure to the left. The basal bulla of the clasps is larger on the right side, and has the terminal process on that side well developed, much for size as in *bombyliformis*, but straighter, with a more slender shaft and more globular head, armed with quite long bristles on its dorsal side. On the left side, the smaller bulla terminates in a short thimble-shaped process, not $\frac{1}{3}$ as long as that on the other side; it carries a few bristles. On the right side the flat process of the valve diminishes in width from about its middle. On the left side, it begins to diminish close to the base, and the valve is very narrow about $\frac{2}{5}$ from the base and gets a little broader again at the end.

I may note here that I call the lateral movable pieces valves or clasps. The flat expanded portion I so describe, or call it valve simply. The knobs, hooks, spines, etc., often double, that lie within this, basally and ventrally, but always firmly soldered to it, so that they move together, I call the harpe. The upper piece, with a single or double spine above and another below the anus, I call the tegumen. The central tubular piece of chitin I call the *ædœagus*, reserving the name of penis for the eversible membrane at the summit of this. There is often a membranous, or even more or less chitinous sheath at the base of the *ædœagus;* I call this the sheath. There have been

so many synonyms for all these parts that this explanation is probably desirable.

None of the following have any detected asymmetry except in the *ædœagus*.

The asymmetry of the *ædœagus* seems to be so universal in Sphinges that only a few, as examples of different manifestations of the tendency, can be given. They are not always referrible to any fundamental type.

Aellopus fadus.—There is no recognizable difference on the two sides, except in the *ædœagus*, which is long and slender, and has the opening to the right side, and beyond it, springing from the left side, is a long hair-like style, of about 2 m.m. in length.

Sataspes infernalis.—No very distinct unilateral variation is detected; the *ædœagus* is slender and delicate, and has no spines, etc., but it is not quite positively symmetrical; the whole of the appendages are of a very different type to any other species examined. The dorsal process of the tegumen consists of two widely-separated downward-directed hooks.

Rhodosoma triopus.—Very robust, especially the tegumen; the only unilateral structure is the termination of the *ædœagus*. The *ædœagus* is short and very thick, about 3·5 m.m. long and 0·7 wide; an extremely strong spine arises on the left side, and bending down at once, curves round beneath and close to the lower margin of the chitinous aperture of the *ædœagus*, its sharp apex reaching as far to the right side as that margin of the tube of the *ædœagus*.

S. stellatarum.—The *ædœagus* is very robust, the opening to the left. The right side carries a narrow longitudinal dark chitinous plate, with two rows of hooks directed backwards, this plate basally fades into the general tube structure, apically it projects beyond the tube in a thickened knob, with an angular end, and giving off on its dorsal margin a large scimitar-like spine or process that curves round the dorsal margin of the tube, and has a row of strong spines along its outer or upper edge. Within the tube are seen two long slender spatula-like pieces, which have probably something to do with the protrusion of the eversible membrane (the true penis?). I see these in this species, they probably exist in all in some form; the thickness of the *ædœagus* makes them more obvious here.

Macroglossa belis has the *ædœagus* very thick and with

the terminal spine starting dorsally, and curving round its dorsal margin to the left side.

Macroglossa bengalensis has a thick *ædœagus* with the right margin swollen and armed with spines. This species has *two* definite spines to harpe (like some Sphinges).

Rhopalopsyche nycteris has a very thick *ædœagus*, with chitinous slips included, it has a thickened margin dorsally and to the right, ending on the left in a hook following the margin of the terminal opening, with its sharp apex below the left margin, the distal margin of this hook or spine is armed by a row of sharp points.

In *Pterogon proserpina* the parts seem to be quite symmetrical except that the *ædœagus*, which is a chitinous tube, exposed for about 1 m.m. of its length, and about ·25 m.m. its diameter, is slightly expanded terminally, and appears to be longer on the left side, and to have a slightly projecting flanged margin at this side of the extremity. This flange is in fact a flange for about half its length, but its lower extremity is free, and terminates in a fine point. This free extremity, however, has the same curve as the portion attached to the margin of the tube, and is close to the portion of the margin of the tube to which it corresponds. The other extremity curving round the dorsal margin, curves in a basal direction, and so fades away on the right side of the tube.

Enyo lugubris.—The *ædœagus* is a rather long tube, with delicate transparent walls, and has a spine of stronger, darker tissue, in line with it projecting from left aspect of dorsum beyond left side of opening (like a bayonet on a gun-barrel). The length of this fine spine is nearly 1 m.m. There is no other appreciable asymmetry.

Deidamia inscripta.—The only lateral inequality is in the *ædœagus*, which is about 3 m.m. long and ·55 thick, at the extremity, a thick hook arises on the *left* side, and curves round the upper margin of the terminal opening, almost indeed partially over it, and terminates in a fine point on the right side. Comparing this with *R. triopus*, one queries whether a half rotation of the organ has not been made in one or other specimen in preparation. I describe what is before me; another preparation must be made.

Ph. lineata.—The *ædœagus* here is wide and short. The appearances might be produced, if first the tube were perfectly cylindrical, with a terminal opening continued ventrally by a longitudinal slit, then let the two sides of

the opening be pressed together, the left side yielding most; let the right side be a little longer than the left, and margined by a thick chitinous ridge, beginning by a thicker portion at the extreme dorsum, where the left side is hinged to it and is capable of moving to and fro, forming a lid or door; the chitinous margin gets narrower as it approaches the lower angle, ending in a point, its outer edge carrying a row of strong sharp spines. The appearance of this ridge is almost identical with the spine in *stellatarum*, but there it is free, here it is attached to the edge throughout its length.

Ce. euphorbiæ.—The structure of the *ædœagus* is very similar to that in *lineata*. The extremity is laterally compressed, and rounded from above downwards, the right side is firm, the left forms a valve or flap capable of closing against and within the right, or opening out. At the upper and lower angles are small soft processes. The right side has a thick chitinous margin, with hooks almost hidden along its basal margin, and smaller than those in *lineata;* except for its recalling *lineata*, it would not, as *lineata* does, suggest the considerably different structure of *stellatarum*.

Ce. galii.—The *ædœagus* has a delicate cylindrical tube, the angular termination is dorsal, and on the right (45°) it terminates in an angular margin like an arrow-head, added to it, *i.e.* at its central protruding angle it is a narrow piece, clearly marked off from (and raised above) the tube behind it, and continues so to each lateral point, these are nearly but not quite the same as each other, the lower (right one) running more directly basally, each carries several minute spines at its proximal end.

Therctra lucasii has the right side below strongly chitinized, towards the extremity of the *ædœagus*, above this, quite to the right side it is produced to a blunt point, longer than a similar process on the left side, from practically the extremity of this a short spine is directed upwards and a little to the left along the upper part of the left margin; its length is about ·4 m.m.

H. celerio. The *ædœagus* is a slender tube about ·3 m.m. in diameter, regular and cylindrical, on the right side somewhat dorsally is at the extremity a thickened darker chitinous piece produced to a point. One would say this was a symmetrical dorsal structure, and that the tube was turned round, dorsum to the right, 45°, were it not that there runs down from either side the apex outside

a ridge with fine serrations. On the upper dorsal margin this ridge is practically along the margin, on the lower (right) margin it is unarmed along the margin, but serrate where it runs almost directly forwards, along and parallel to the axis of the tube.

Eu. elpenor.—Symmetrical except the *ædœagus*, which has a ridge starting at the extremity dorsally, and passing obliquely forwards and to the left, and carrying a row of hooks or spines directed forwards (backwards if one calls the direction of the end of the penis forwards). The *ædœagus* is comparatively short and thick.

Eu. porcellus.—So far as asymmetry is concerned, the description of *elpenor* might be accurately applied to *porcellus*. There is some variation in individuals as to the oblique ridge. It is sometimes much less pronounced than in others. The genitalia are very much alike in these two species in all respects.

D. idricus.—There projects from the *ædœagus*, close to its extremity and on the right side, but close to the ventral aspect, a short hook, that projects downwards and curves to the left.

Nephele viridescens.—The prolonged and thickened margin of the *ædœagus* is here on the left side, but it is prolonged over the dorsum so that its very thickened end is nearly 60° to the right of the medio-dorsum, the thinned termination below to the left, almost reaches the ventral aspect. The margin of this flange has a series of rather long, very appressed spines. The thickened (right) end of the ridge projects some distance beyond the rest of the tube, and carries a short corkscrew-like spine, which is directed as it curls first distally then dorsally and finally to the right.

Dilophonota ello.—*Ædœagus* rather long and slender, terminating in an oblique opening, giving a sharp apex to right side. The lower margin of the opening has from this apex a ridge carrying a few sharp spines, the upper margin, from the apical point, runs more directly forwards in line with the tube, and carries a much greater number of very closely-packed smaller spines. The general scheme very similar to *Celerio*.

Acosmeryx anceus.—Margin longest right upper corner. A serrated flange runs down from this on lower (right) margin, and from the side of the extremity there is a spine directed to the left across the upper margin about ·5 m.m.

in length, the ridge running back dorsally does not appear to carry any spines.

Acosmeryx cinerea.—The parts are almost quite symmetrical. The opening of the *ædœagus* is terminal, and the right side seems rather more solid and armed by fine teeth, not clearly seen on other side.

Sphinx pinastri.—The *ædœagus* here is extremely long and slender, and terminates by slightly curving to the left. The right side is produced into a long process, of which about 1 m.m. is free, and nearly twice such a length runs back along the tube as a dark chitinous thickening. The tube is rather swollen along this portion. Apparently from the opposite side of the opening, but really, I believe, as part of the eversible membrane, that happens to be here displayed are two shorter more delicate processes that are placed against this longer process, one on either side of it. These two are not quite identical.

Ag. convolvuli.—The asymmetry, if present, is inappreciable.

M. tiliæ.—No asymmetry detected.

M. atropos.—Apparently quite symmetrical.

Sphinx ligustri.—There is practically no asymmetry. The prolonged triangular apex appears to be dorsal and without differentiation on its two margins.

Ambulyx rostralis.—The asymmetry here is reduced to a slight appearance, of the *ædœagus* being rotated a little, and some doubtful microscopic details. It is difficult to say positively that there is or is not asymmetry.

Amorpha populi.—The asymmetry here affects certain rather numerous very long thick spines on the eversible membrane at the opening of the *ædœagus*, these are more numerous, stronger, and distributed more distally on the left than on the right side.

Smerinthus ocellatus.—The eversible membrane here is armed with numerous spines as in *Sm. populi*, they are smaller and more curved than in *populi*. Their asymmetrical arrangement is quite subsidiary to the very marked structure of the termination of the *ædœagus*, which has an extraordinarily strong thick process on the left side, directed outwards, and ending in a rather sharp spine, curved so that the point is directed dorsally. The opening is thus thrown over to the left side.

This paper ought to include a reference to some facts recorded by Professor Poulton, as to asymmetry in the

male appendages, in his classical papers on the Morphology of Lepidopterous pupæ, in the Linnean Transactions for 1890 (Vol. V., Zool.), and especially those concerning *Hemaris fuciformis* on pp. 200, 206 and Plate XX, fig. 26. I have examined male pupæ of *Hemaris fuciformis*, *H. tityus* and *H. croatica* as well as of *Cephonodes kingii*, and all the specimens agree very closely with Professor Poulton's figure. All show the twisting of the two tubercles, so that that on the left side is more to the front and if anything larger and more prominent than that on the right, and have the furrow obliquely placed so that its anterior end points to the right, instead of directly forwards. They also show, as in Professor Poulton's figure, the posterior margin of the eighth segment, sinuated, opposite the advanced tubercle on the left side. He also figures less obvious asymmetry in *Ce. euphorbiæ* and *A. populi*.

In *Arge*, where he also detects pupal asymmetry, the structures render it very difficult in the imago to say whether there is any rotation of the *Ædæagus* or not.

These pupal facts render it probable that the asymmetry of the *Ædæagus* is at first (at least in some cases) really a twisting or rotation, and not, as it obviously is later in most cases, a difference in structure on the two sides.

Professor Poulton's caution, in noting the asymmetry in *H. fuciformis* as that "of the individual represented," and so avoiding a generalization for which he had not apparently the materials, is scientifically perfect. His surmise that the asymmetry may be an irregularity following from the extremely ancestral character of the organs does not seem to be borne out, the pupal asymmetry being almost certainly secondary to comparatively recently acquired imaginal asymmetry.

Explanation of Plate XXIV.

Figs. 1–5. Appendages of *Cephonodes hylas*, L. (India).

Fig. 1. Seen from left side, × 8 diam. Shows relative size and form of left and of right clasps.

,, 2. Same from right side showing right clasp, × 8 diam.

,, 3. Extremity of *ædœagus* showing spine beyond opening, × 140 diam.

4, 5. Lateral and dorsal views of tegumen to show twist, × 9 diams.

,, 6. Left clasp of *Ceph. hylas*? (Africa?) showing somewhat different form, × 12 diam.
Torn end at separation shows want of definite articulation.

,, 7. Left clasp of *Ceph. kingii*, Macl., from within, × 7 diam.

,, 8. Right ,, ,, ,, ,, ,,

,, 9. *Ædœagus* of ,, ,, ,, ,, × 36 diam.
The *ædœagus* is shorter, more robust, and with the opening much further from the extremity than in *Ceph. hylas*, 0·7 m.m. instead of 0·3. In this, in the form of clasps, and in the trifling, if any, asymmetry in the tegumen, *Ceph. kingii* is much nearer to *Hemaris* than it is to *Ceph. hylas*.

Explanation of Plate XXV.

Figs. 1–4. Appendages of *Hemaris fuciformis*, L. (*loniceræ*, Zell.).

Fig. 1. Clasps expanded and seen from below (valves foreshortened), × 10 diam.

,, 2. Left clasp seen from within, × 10 diam.

,, 3. Right ,, ,, ,, ,, ,, ,,

,, 4. *Ædœagus* ,, ,, below, × 12 ,,

,, 4a. ,, ,, a little from the left, showing that opening is really terminal, and that the apparent point is really the thin margin of opening.

Figs. 5–9. Appendages of *H. tityus*, L. (*scabiosæ*, Zell.).

Fig. 5. Clasps seen from below (less separated than *fuciformis* in Fig. 1, their general relation to each other is the same in both species), × 9.

,, 6. Left clasp seen from within, × 11 diam.

,, 7. Right ,, ,, ,, ,, ,, ,,

,, 8. *Ædœagus* and bases of clasps from below, the point here is a true point 0·7 m.m. beyond the opening, × 15 diam.

,, Tegumen, lateral view, × 15. No asymmetry.

Figs. 10–11. *Ædœagus* of *Macroglossa stellatarum*, L.

Fig. 10. Shows hook which passes across dorsum to left side. The figure accurately follows preparation pressed on glass slide, in which the hook has been forced from its somewhat close apposition to the margin of the tube, × 15.

,, 11. The same to show eversible membrane extended with its two apparently asymmetrical chitinous filaments attached, × 12. This figure is rather from above, than a lateral view. Fig. 10 rather from below, but both are from flattened specimens.